*CLAIM AMENDMENTS*

1. (Currently Amended) A semiconductor base comprising a substrate and a semiconductor crystal formed on said substrate by vapor phase growth, wherein

(a) the semiconductor crystal is a GaN group semiconductor crystal defined by $Al_x Ga_{1-x-y} In_yN$ where $0 \leq x \leq 1$ and $0 \leq y \leq 1$,

(b) the substrate is a base on which the semiconductor crystal has been grown, and the substrate is made of sapphire, wherein the sapphire is C-plane, A-plane, or R-plane, SiC, wherein the SiC is 6H, 4H, or 3C, GaN, Si, Spinel, ZnO, GaAs, or NGO,

(c) the substrate has a concavo-convex surface as a crystal growth plane, and

~~(c)~~ (d) the GaN group semiconductor crystal [is grown exclusively from an upper part of a convex part of the concavo-convex surface] has been grown in the lateral direction from the upper part of the convex part of the concavo-convex surface as the starting point and joined to cover the concavo-convex surface, leaving a cavity in the concave part, and the part grown laterally comprises an area having a reduced dislocation density.

2. (Canceled)

3. (Original) The semiconductor base of claim 1, wherein the convex parts of the crystal growth plane of the substrate form parallel stripes.

4. (Currently Amended) The semiconductor base of claim 3, wherein the [semiconductor crystal is InGaAlN and a] longitudinal direction of the stripe is [in parallel to a (1-100) plane] the <1-100> direction of the [InGaAlN] GaN group semiconductor crystal.

5. (Canceled)

6. (Original) The semiconductor base of claim 1, wherein the concave part of the concavo-convex surface of the substrate is covered with a mask on which the crystal cannot substantially grow, and the semiconductor crystal is crystal grown exclusively from the upper part of the convex part of the concavo-convex surface of the substrate.

7. (Currently Amended) ~~A~~ The semiconductor base of claim 1, 3, 4, or 6 comprising a first semiconductor crystal layer having [obtained by making a crystal growth plane of a substrate] a concavo-convex surface, and [crystal growing exclusively from an upper part of a convex part of the concavo-convex surface by vapor phase crystal growth,

and] a second semiconductor crystal layer formed by [making a surface of the first semiconductor crystal layer a concavo-convex surface and similarly crystal growing exclusively] growing in the lateral direction from ~~an~~ the upper part of the convex part of the concavo-convex surface as the starting point, wherein the first and second semiconductor crystal layers are joined with each other to cover the concavo-convex surface, leaving a cavity in the concave part.

8. (Original) The semiconductor base of claim 7, wherein the concave part of the concavo-convex surface of the substrate is covered with a mask on which the crystal cannot substantially grow, the first semiconductor crystal layer is formed by crystal growth exclusively from the upper part of the convex part of the concavo-convex surface of the substrate, the convex part of the concavo-convex surface of the first semiconductor crystal layer is covered with a mask, on which the crystal cannot substantially grow, and the second semiconductor crystal layer is formed by crystal growth exclusively from the upper part of the convex part of the concavo-convex surface of the first semiconductor crystal layer.

9. (Currently Amended) A semiconductor base comprising ~~a third~~ plural semiconductor crystal ~~layer~~ layers formed in multiplicity by making a surface of the second semiconductor crystal layer of the semiconductor base of claim 7 a concavo-convex surface, and similarly vapor phase growing thereon~~, or plural~~ a third semiconductor crystal ~~layers formed in multiplicity~~ layer by vapor phase growth as with the second semiconductor crystal layer or by repeating a similar ~~steps~~ step.

10. (Currently Amended) A semiconductor base comprising ~~a third~~ plural semiconductor crystal ~~layer~~ layers formed in multiplicity by making a surface of the second semiconductor crystal layer of the semiconductor base of claim 8 a concavo-convex surface, covering the concave part with a mask on which the crystal cannot substantially grow, and similarly vapor phase growing thereon~~, or plural~~ a third semiconductor crystal ~~layers formed in multiplicity~~ layer by vapor phase growth or by repeating a similar ~~steps~~ step.

11.-21. (Canceled)

22. (New) A semiconductor base comprising a substrate and a semiconductor crystal formed on said substrate by vapor phase growth, wherein

(a) the semiconductor crystal is a GaN group semiconductor crystal defined by $Al_x Ga_{1-x-y} In_y N$, where $0 \leq x \leq 1$ and $0 \leq y \leq 1$,

(b) the substrate is a base on which is the grown semiconductor crystal, and which is made of sapphire, wherein the sapphire is C-plane, A-plane, or R-plane, SiC, wherein the SiC is 6H, 4H, or 3C, GaN, Si, Spinel, ZnO, GaAs, or NGO,

(c) the substrate has a concavo-convex surface as a crystal growth plane, and

(d) the semiconductor crystal having been grown laterally from the upper part of the convex part of the concavo-convex surface and having been grown from a surface of the concave part as starting points, such that the crystal grown laterally from the upper part of the convex part of the concavo-convex surface and the crystal grown from the surface of the concave part are joined to cover the concavo-convex surface of the substrate.

23. (New) The semiconductor base of claim 22, wherein the concave part of the substrate is filled with a semiconductor crystal and devoid of a cavity.

24. (New) The semiconductor base of claim 22, wherein the convex parts of the crystal growth plane of the substrate form parallel stripes.

25. (New) The semiconductor base of claim 24, wherein the longitudinal direction of the stripe is the <1-100> direction of the GaN group semiconductor crystal.

26. (New) The semiconductor base of any of claims 22-25, wherein the surface of the first semiconductor crystal of the semiconductor base has a concavo-convex surface and comprises a second semiconductor crystal having been grown laterally from the upper part of the convex part of the concavo-convex surface and having been grown from a surface of the concave part as starting points, such that the crystal grown laterally from the upper part of the convex part of the concavo-convex surface and the crystal grown from the surface of the concave part are joined to cover the concavo-convex surface of the substrate.

27. (New) The semiconductor base of claim 26, wherein the concave part of said substrate is filled with a semiconductor crystal and devoid of a cavity.

28. (New) A semiconductor base comprising plural semiconductor crystal layers formed in multiplicity by making a surface of the second semiconductor crystal layer of the

semiconductor base of claim 26 a concavo-convex surface, and similarly growing thereon, a third semiconductor crystal layer by vapor phase growth or by repeating a similar step.

29. (New) A semiconductor base comprising plural semiconductor crystal layers formed in multiplicity by making a surface of the second semiconductor crystal layer of the semiconductor base of claim 27 a concavo-convex surface, and similarly growing thereon, a third semiconductor crystal layer by vapor phase growth or by repeating a similar step.

*REMARKS*

*The Present Invention*

The invention provides a semiconductor base comprising a substrate and a semiconductor crystal formed on the substrate by vapor phase growth. More specifically, the inventive semiconductor base comprising a substrate and a semiconductor crystal possesses the following characteristics:

(a) a GaN group semiconductor crystal, and

(b) concave and convex features formed on the substrate, wherein the GaN group semiconductor crystal is grown in the lateral direction from the upper part of the convex parts of the concave and convex features.

In the above-mentioned characteristic (a), the crystal to be grown is a GaN group semiconductor crystal. Naturally, the material of the substrate is limited to those that permit growth of the crystal, namely, sapphire (C-plane, A-plane, or R-plane), SiC (6H, 4H, or 3C), GaN, Si, Spinel, ZnO, GaAs, and NGO.

In the above-mentioned characteristic (b), the crystal grows in the concave part, and the mode of the growth is defined in two ways (see independent claims 1 and 22). In amended claim 1, the inside of the concave part is void of the GaN group crystal layer, while, in claim 22, the crystal grown from the convex parts and the crystal grown from the concave part are joined. Claim 23 further specifies that the inside of the concave part is completely filled with a GaN group crystal. Because of characteristic (b), a GaN group crystal grown in the lateral direction from the convex parts contains an area with a low dislocation density, and both embodiments of the invention (i.e., the embodiments defined by both claims 1 and 22) provide the effect that the GaN group crystal layer, grown on the substrate as a whole, has a low dislocation density and high quality.

*The Pending Claims*

Claims 1, 3, 4, 6-10, and 22-29 are pending.

*The Amendments to the Claims*

The claims have been amended to point out more particularly and claim more distinctly the present invention. Claims 1, 4, 7, 9, and 10 have been amended. These amendments are supported by the specification at, for example, page 4, line 13, through page 6, line 11. Claims 22-29 have been added and are supported by the specification at, for

example, page 13, lines 2-20, and Figure 3. Claim 5 has been canceled. Claim 2 had been canceled previously. Claims 11-21 have been canceled as directed to nonelected subject matter in response to a restriction requirement. No new matter has been added by way of these amendments.

*The Office Action*

The Office Action has rejected claims 1, 3, and 5-10 under 35 U.S.C. § 103(a), as obvious in view of Vichr et al. (U.S. Patent No. 5,614,019) in combination with Kawasumi et al. (JP 10-178026), Shigeta et al. (U.S. Patent No. 5,729,701), Usui et al. (U.S. Patent No. 6,252,261), Shibata et al. (JP 10-107317), and/or JP 9-312418. Claim 4 is rejected under 35 U.S.C. § 103(a), as obvious in view of Vichr et al. in combination with Kawasumi et al., Shigeta et al., Usui et al., and/or Vaudo et al. (U.S. Patent No. 6,156,581). Reconsideration of the obviousness rejections is hereby requested.

*Discussion of Obviousness Rejection*

According to the Office, Vichr et al. discloses a method for growing large, single crystals. The Office concedes that Vichr et al. does not teach the selective growth of crystals from the upper part of a convex part of a concavo-convex surface of the substrate or the specific directional growth configuration. As stated previously, Vichr et al. relates to "diamond, cubic boron nitride, silicon carbide" crystal growth (column 1, lines 14-15). These crystals are completely different from the GaN group crystal that is a characteristic of the present invention (i.e., characteristic (a) of the present invention, as discussed above). Diamond, cubic boron nitride, and silicon carbide differ as to their atoms, crystal structure, and physical properties, and have no relevance to each other, let alone to a GaN group crystal. In addition, the material of the base substrate also is completely different from that of the present invention. For the substrate, Vichr et al. describes an "original single crystal diamond seed plate 12" (column 7, line 60). While Vichr et al. discloses a method of growing a crystal on a substrate surface having concave and convex features, Vichr et al. is silent regarding the characteristic of the present invention in which a GaN group crystal is grown in the lateral direction from the upper part of the convex parts on a substrate (i.e., characteristic (b) of the present invention, as discussed above).

The Office contends that Kawasumi et al. discloses a crystal growth method in which there is selective growth of crystals on the concave part of the substrate. Kawasumi et al. discloses crystal growth of a II-VI group semiconductor. In the present invention, the GaN

group crystal to be grown is a III-V group semiconductor, which is considered completely different from a II-VI group semiconductor. Moreover, while Kawasumi et al. discloses that convex parts are formed on a substrate, Kawasumi et al. fails to disclose that a GaN group semiconductor crystal is grown in the lateral direction from the upper part of the convex parts (i.e., characteristic (b) of the present invention, as discussed above).

Shigeta et al. allegedly discloses a method of growing SiC single crystals with the claimed directional structure. Shigeta et al., however, teaches the growth of a SiC single crystal on a Si substrate, both of which (SiC and Si) are different from the crystal and substrate of the present invention (see, e.g., pending independent claims 1 and 22). Shigeta et al. is silent on the processing of a substrate to form concave and convex features, let alone a semiconductor base in which a GaN group crystal is grown in the lateral direction from the upper part of the convex parts on a substrate. Therefore, the present invention is completely different from disclosure of Shigeta et al.

The Office contends that Usui et al. discloses a GaN crystal film, a Group (III) nitride semiconductor wafer, and a method of growing crystals with the claimed crystal configuration. Usui et al. discloses growing a GaN group crystal using a mask-method, which is described as a conventional technique in the present application. While Usui et al. discloses the same material as the present invention, Usui et al. does not describe the feature in which a GaN group crystal is grown from the convex parts over the concave part (in air), which is a cavity, by lateral growth (i.e., characteristic (b) of the present invention, as discussed above).

The Examiner concedes that the combination of Vichr et al., Kawasumi et al., and Shigeta et al. does not result in the present invention. In particular, the Examiner acknowledges that the combination of these references "do not disclose the required compound semiconductor crystal and the exact formula for the required compound semiconductor crystal" (Office Action, p. 2, last paragraph). In an effort to address these deficiencies, the Examiner alleges that Shibata et al. and JP 9-312418 disclose a semiconductor device with the required compound semiconductor crystal and formula, respectively (Office Action, sentence bridging pages 2 and 3). Shibata et al. and JP 9-312418, however, merely disclose a GaN group device and do not disclose a concavo-convex surface processing of the substrate or a device in which a GaN group crystal is grown in the lateral direction from the upper part of the convex parts on a substrate, as required in the

present invention. Accordingly, even the combination of the Vichr et al., Kawasumi et al., Shigeta et al., Shibata et al., and JP 9-312418 does not result in the disclosure of the present invention as defined by the pending claims.

The other reference relied upon by the Examiner is Vaudo et al., which is said to disclose a GaN-based device containing a (Ga, Al, In)nitride base layer. Vaudo et al., however, does not teach or suggest concavo-convex surface processing of the substrate as recited in the pending claims. Thus, the further addition of the disclosure of Vaudo et al. to the aforementioned combination of references still does not result in the disclosure of the present invention as defined by the pending claims.

Vichr et al., Kawasumi et al., Shigeta et al., Usui et al., Shibata et al., JP 9-312418, and Vaudo et al. each disclose random elements of semiconductor technology. Indeed, Vichr et al., Kawasumi et al., and Shigeta et al. disclose crystal and substrate materials that are completely different than those of the present invention. Moreover, due to the different crystal structures which are the subject of these cited references, one of ordinary skill in the art would not be motivated to combine the disclosures of these cited references for any reason. Even if, for the sake of argument, the disclosures of the cited references are combined, all of the elements of the present invention, as defined by the pending claims, are not taught or suggested. Specifically, the cited references, alone or in combination, do not disclose a semiconductor base in which either (a) a GaN group semiconductor crystal has been grown in the lateral direction from the upper part of the convex part of the concavo-convex surface as the starting point and joined to cover the concavo-convex surface, leaving a cavity in the concave part, wherein the part grown laterally comprises an area having a reduced dislocation density, or (b) the semiconductor crystal has been grown laterally from the upper part of the convex part of the concavo-convex surface and has been grown from a surface of the concave part as starting points, such that the crystal grown laterally from the upper part of the convex part of the concavo-convex surface and the crystal grown from the surface of the concave part are joined to cover the concavo-convex surface of the substrate.

Accordingly, the cited references do not teach or suggest all the features of the present invention as defined by the pending claims, even when considered collectively. In the absence of a teaching or suggestion of all of the claim elements, the obviousness rejection of the pending claims is improper and should be withdrawn.

*Conclusion*

The application is considered in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

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